Grass Swale

Definition

A grass swale is a stable turf, parabolic or trapezoidal channel used for water quality or to convey stormwater runoff, which does not rely on the permeability of the soil as a pollutant removal mechanism. The total suspended solids (TSS) removal rate for a grass swale designed according to this chapter is 50%.

Purpose

Grass swales are used to reduce particulate pollutants due to settling and filtration. Particulate pollutant removal occurs when the low velocities and shallow depths allow particulate settling and the grass blades act to filter runoff from the water quality design storm. For larger storm events, the swale can also be used as an alternate to traditional storm sewer system.

Conditions Where Practice Applies

Grass swales are best suited to transport and treat stormwater runoff generated from impervious surfaces with small drainage areas, such as roadways and parking lots. Grass swales can be used wherever soil conditions, slopes, and sunlight permit the establishment and maintenance of a dense stand of vegetative cover. Grass swales are typically installed in low gradient lawns, median strips, parking lot islands, unused lot areas, and utility easements, where downstream flow attenuation is provided to control larger storm events.

Design Criteria

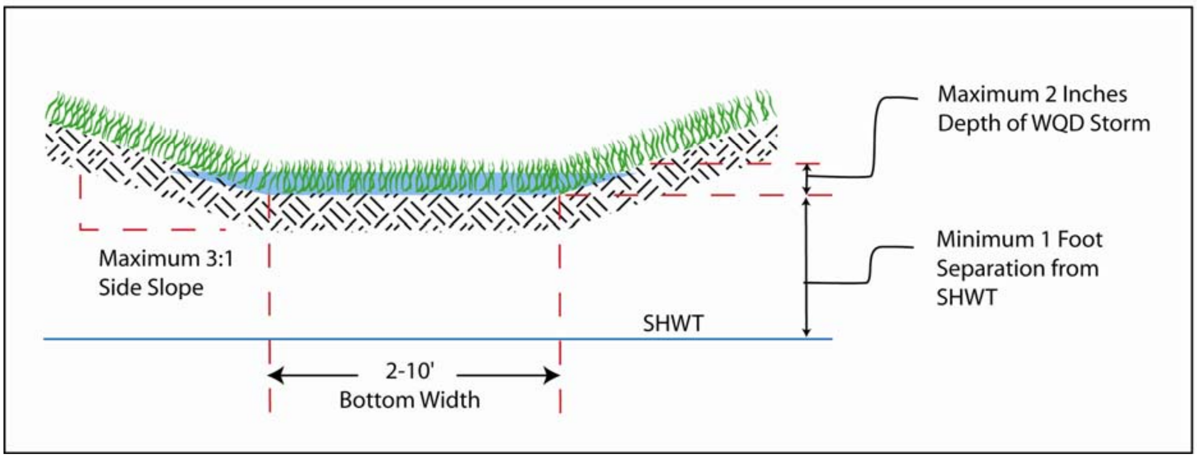
Grass swales treat the runoff from the water quality design storm and can also be designed as a vegetated conveyance for larger storm events. Grass swales designed in the following manner can receive credit for 50% TSS removal rate.

- The swale can be trapezoidal or parabolic, with a minimum bottom width of 2 feet and a maximum bottom width of 10 feet.

- Grass height shall be established and maintained at 3-6 inches.
- The maximum allowable depth in the swale is 2 inches for the Water Quality Design storm, using Manning's equation and a Manning's "n" value of 0.25. **This Manning's "n" value shall only be used with the Water Quality Design Storm for the design of the grass swale BMP for TSS removal.**
- The minimum swale length is 50 feet.
- The maximum allowable side slope is 3:1, with a recommended side slope of no more than 4:1.

Note: All grass swales must be stabilized in accordance with the requirements in the *Standards for Soil Erosion and Sediment Control in New Jersey (SESC)*. Channels may also be designed for purposes other than water quality, such as stormwater conveyance. Grass swales that are not designed for water quality may still receive credit as a nonstructural stormwater management strategy for the conveyance of stormwater runoff. In such cases, the criteria in this chapter do not apply. Additional information on nonstructural stormwater management strategies is available in Chapter XXX.

Figure 6.5-1: Swale Profile



- The maximum allowable velocity of the Water Quality Design storm is 0.9 feet per second.
- There shall be a minimum of 1 foot separating the bottom of the swale from the seasonal high water table (SHWT).
- The minimum longitudinal slope is 2%. This slope may be reduced to 1.5% if there is a minimum of 2 feet separation from the SHWT and the soil has a field tested permeability rate of at least 1 inch/hr in accordance with the procedures at Appendix E. The maximum longitudinal slope is 10%.
- Grass swales must be stable in accordance with the Standard for Grassed Waterways in the *Standards for Soil Erosion and Sediment Control in New Jersey.*

TSS Removal Rates for Different Swale Configurations

Due to differences in swale configurations, the area treated by a swale can vary. A list of three configurations to achieve a TSS removal rate of 50% is provided below.

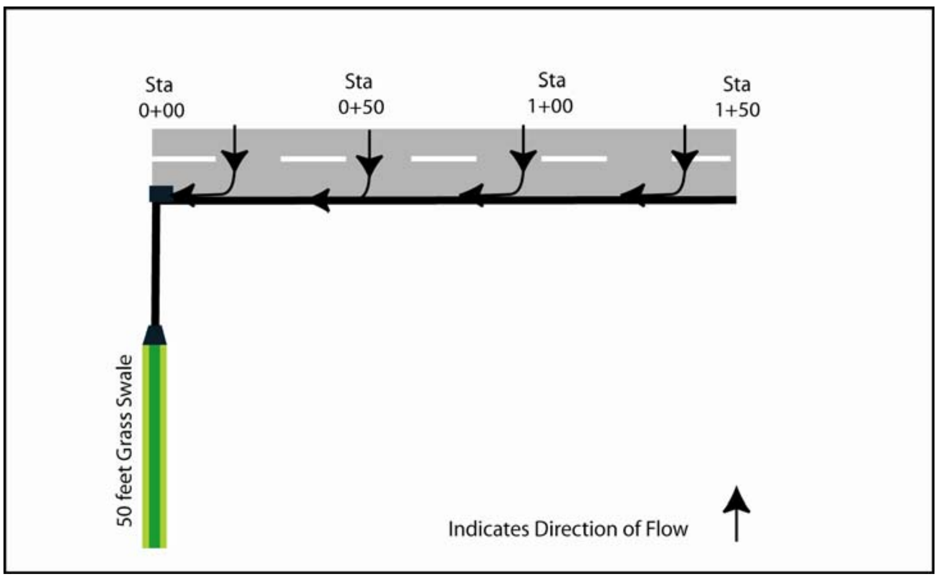
1. A 50 foot or longer swale for systems with point discharge. (Figure 6.5-2A)
2. A 200 foot or longer swale with distributed discharge. (Figure 6.5-2B)
3. Distributed discharge swales that are less than 200 feet are given 50% TSS removal rate for the length of swale upstream of 50 feet. (Figure 6.5-2C)

The figures below provide examples of these swale configurations and how the inflow areas are collected. The length of a water quality treatment swale may change based on the configuration.

Inflow Area for Systems with Point Discharge

Figure 6.5-2A shows inflow from impervious cover discharging to the upstream point of a swale. Since the entire 150 feet of roadway section is collected prior to being treated by the 50 feet of swale, a 50% TSS removal rate is provided.

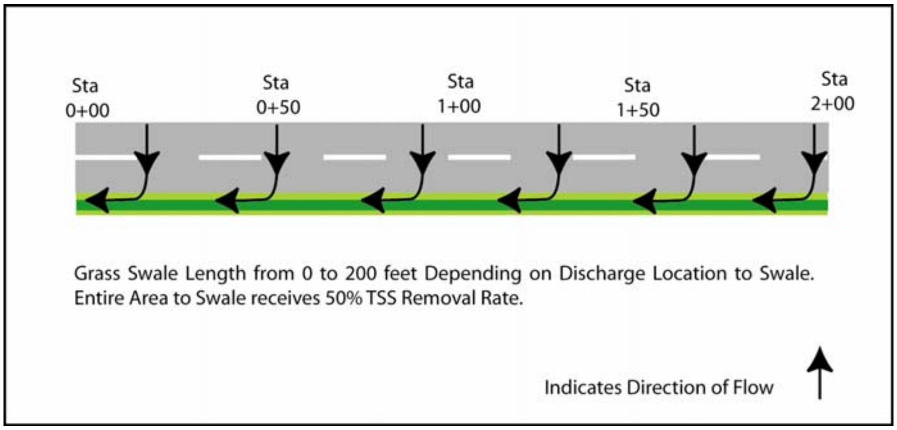
Figure 6.5-2A: Inflow Area for Systems with Point Discharge



Inflow Area for Distributed Discharge

Figure 6.5-2B depicts a 200 foot portion of roadway where the discharge is distributed along the length of the adjacent swale through overland flow. (Note: The inflow area is treated by a swale length that varies from 50 to 200 feet for 150 feet of roadway (Stations 0+50 to 2+00). Based on the research information, the additional treatment provided from Stations 0+50 to 2+00 feet is sufficient to mitigate for the lack of treatment that occurs in the first 50 feet of swale to provide a 50% TSS removal rate for the entire 200 feet.) Therefore, in cases where 200 feet of swale is provided along a roadway, the entire inflow area will receive a 50% TSS removal rate.

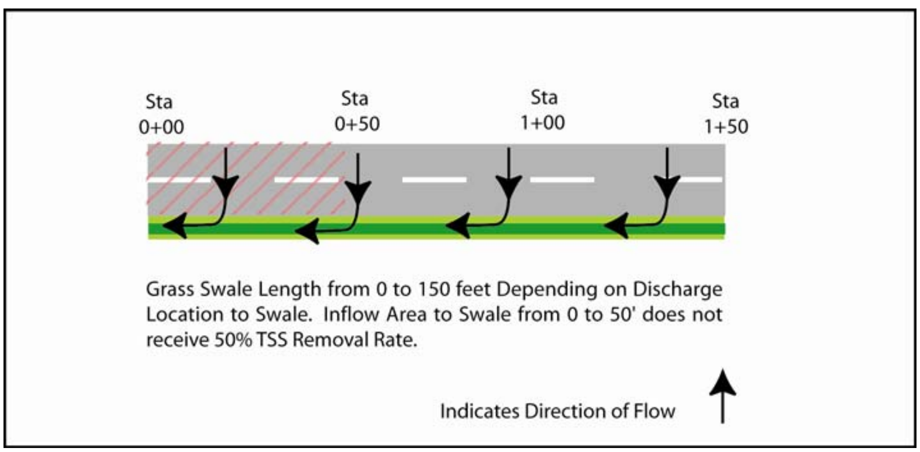
Figure 6.5-2B: Inflow Area for Distributed Discharge



Inflow Area for Distributed Discharges Less than 200 Feet

Figure 6.5-2C below shows that from 50 to 150 feet, the inflow area passes through a minimum of 50 feet. Therefore, 100 feet of roadway is treated by a minimum of 50 feet of grass swale. However, from 0 to 50 feet, the inflow area passes through a length of swale less than the 50 foot minimum. Therefore, only the area from 50 feet to 150 feet receives the 50% TSS removal rate.

Figure 6.5-2C: Inflow Area for Distributed Discharges Less than 200 Feet



Effective Inflow Drainage Areas

As discussed in Figures 6.5-2A, 6.5-2B, and 6.5-2C, different swale configurations determine the allowable portions of the inflow drainage area to achieve the 50% TSS removal rate. This section provides additional examples to determine how and if the TSS removal rate for swales is applicable for a particular configuration.

Figure 6.5-3 provides three different examples for non-linear inflow areas. These configurations are based on the drainage from the impervious area being collected prior to being treated by the swale.

Figure 6.5-3A complies with all of the standards discussed above and receives the 50% TSS removal for the entire area. However, in Figure 6.5-3B, the maximum 2-inch water depth is exceeded for the water quality design storm. Figure 6.5-3C complies with the 2-inch water depth; however, the minimum 50-feet swale length has not been provided. Therefore, Figure 6.5-3B and 6.5-3C do not receive the grass swale TSS removal rate.

Figure 6.5-3: Examples of Non-linear Inflow Area

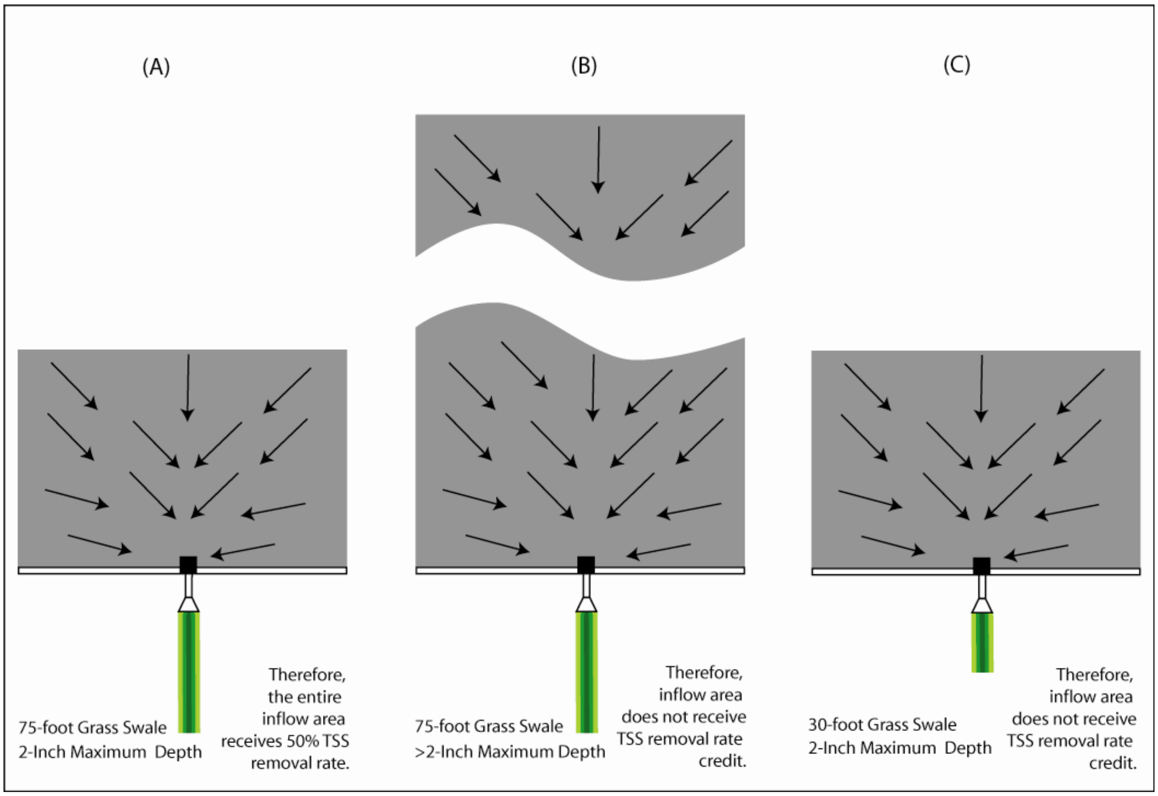
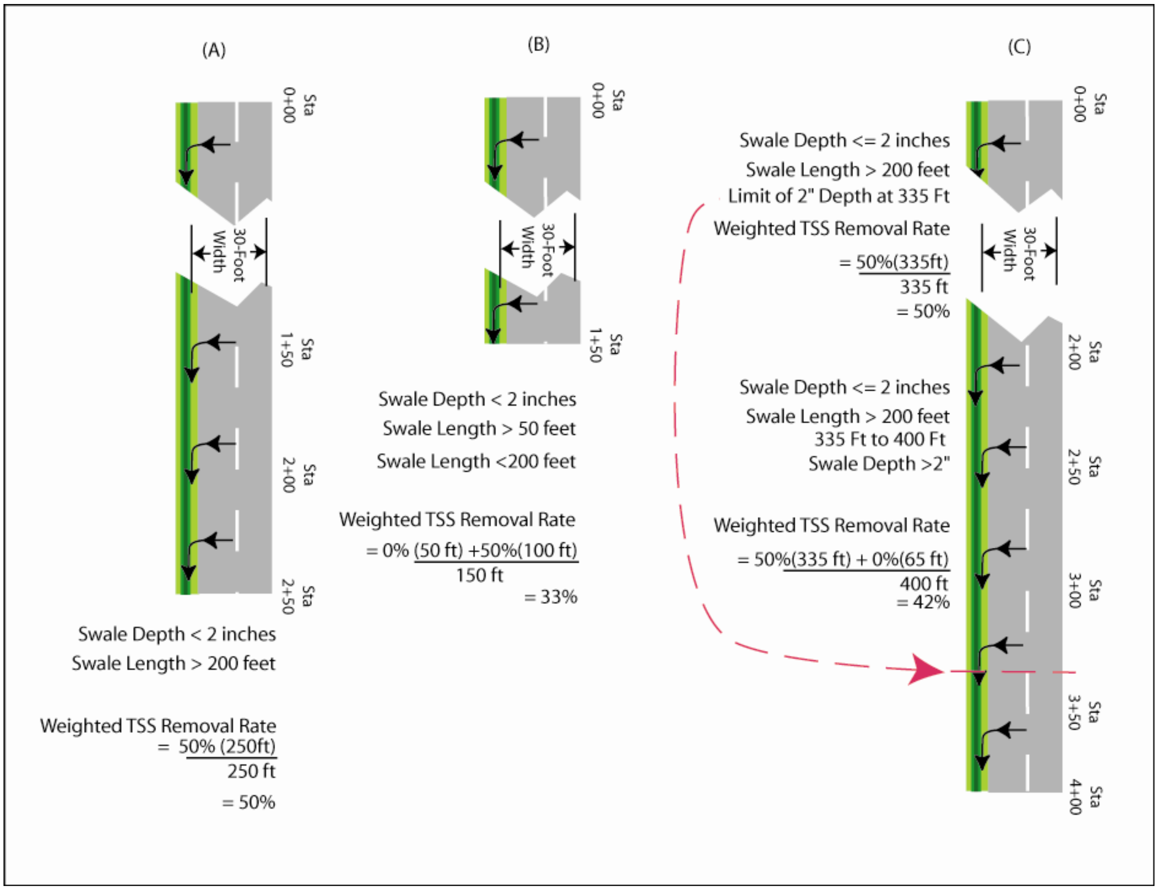


Figure 6.5-4 provides three different examples for a linear inflow area. The configurations are based on the drainage entering from the paved surface onto the adjacent grass swale through overland flow. As the runoff flows down gradient within the swale, the inflow drainage area increases. Figure 6.5-4A demonstrates a swale along a road that complies with all of the standards and receives the 50% TSS removal rate along the entire inflow area. Figure 6.5-4B has a swale where the depth of the water quality design storm is less than 2 inches along its length. However, as discussed on Figure 6.5-2B, only the last 100 feet of swale will receive the 50% TSS removal rate. In order to determine the TSS removal rate for the entire inflow area, an area-weighted TSS removal rate can be determined. For Figure 6.5-4B, the weighted TSS removal rate is 33%. In Figure 6.5-4C, the swale length exceeds 200 feet. However, at Station 3+35, the depth starts to exceed 2 inches for the water quality design storm and continues to exceed 2 inches for the remaining 65 feet. Therefore, the TSS removal rate from Station 3+35 to Station 4+00 is 0% and the weighted TSS removal rate for the length of road is 42%.

Figure 6.5-4: Examples of Linear Inflow Area



Note: Although the last 65 feet of the roadway in Figure 6.5-4(c) does not receive water quality credit, it may qualify as a vegetated conveyance for the purposes of demonstrating the use of nonstructural stormwater management strategies.

Inflow Area for Distributed Discharges with Armor Stabilization

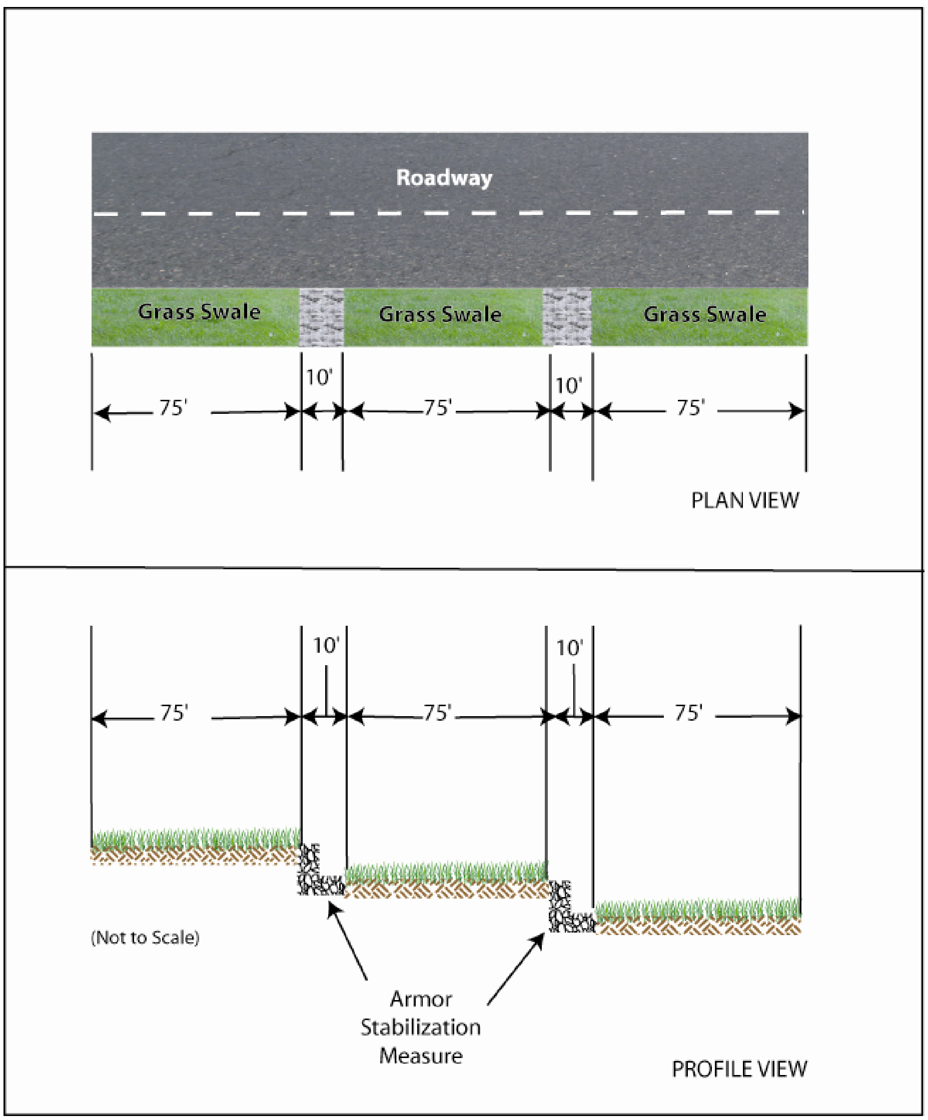
Figure 6.5-5 provides an additional example of flow along a roadway where the discharge is distributed along an adjacent swale through overland flow. The configuration is similar to the configurations in Figure 6.5-2B: however, in this example the swale contains armor stabilization measures within the swale. Armor stabilization is non-vegetative stabilization measures utilized for erosion control. Armor stabilization includes riprap, gabion, and slope protection structures including those used for curb cuts.

As in Figure 6.5-2B, Figure 6.5-5 demonstrates how the inflow drainage area increases as the runoff flows down gradient within the swale. In addition, Figure 6.5-5 demonstrates a roadside swale that complies with all of the standards listed in the Design Criteria section. Thus, if the grass swale is greater than 200 feet in length, it provides the 50% TSS removal rate for the entire inflow area, provided that the swale complies with the following:

- The TSS removal rate achieved is based on the vegetated portion of the swale. The armor stabilization structures are not included in swale length calculations.
- The downstream-most 50 feet of the swale length is vegetated.

The TSS removal rate for the roadway shown in Figure 6.5-5 is based on three segments, each at 75 feet in length, which results in 225 feet of grass swale. The two segments that contain non-vegetative stabilization measures, each 10 feet in length, were not considered in the length calculation. Therefore, since the last 50 feet is vegetated and the total swale length is greater than 200 feet, the entire inflow area to this swale receives a 50% TSS removal rate.

Figure 6.5-5: Example of Distributed Discharges into Grass Swale with Armor Stabilization



TSS Removal Rates for BMPs in Series

The adopted TSS removal rate for grass swales is less than the 80% TSS removal rate typically required in the regulations. As noted in Chapter XX, it may be necessary to use a series of BMPs in a treatment train to achieve the required TSS removal rate.

The Stormwater Management rules at N.J.A.C. 7:8 provide a simplified equation for the total TSS removal rate for two BMPs in series. The use of this equation is not appropriate for the same two BMPs; however, this equation can be used to estimate the combined TSS removal rate of a swale with other types of BMPs.

Maintenance

Effective grass swale performance requires regular and effective maintenance. Chapter 8: Maintenance and Retrofit of Stormwater Management Measures provide information and requirements for preparing a maintenance plan for stormwater management facilities. Specific maintenance requirements for grass swales are presented below. These requirements should be included in the system's maintenance plan. In addition, to these maintenance requirements the system's maintenance plan must include the original cross sections associated with the grass swale.

A. General Maintenance

All grass swales components expected to receive and/or trap debris and sediment should be inspected for clogging, excessive debris and sediment accumulation at least twice annually and as needed. One of the inspections must occur during the non-growing season. Such components may include bottoms, trash racks, low flow channels, outlet structures, riprap or gabion aprons, and cleanouts.

Sediment removal should take place when the swale is thoroughly dry and should not result in the removal of the vegetation. Disposal of debris, trash, sediment, and other waste material should be done at suitable disposal/recycling sites and in compliance with all applicable local, state, and federal waste regulations.

B. Vegetated Areas

Mowing and/or trimming of vegetation should be performed on a regular schedule based on specific site conditions. Grass outside of the grass swale should be mowed at least once a month during the growing season. Grasses within the grass swale should be carefully maintained to provide a minimum grass height of three (3) inches and a maximum grass height of six (6) inches. Grass clippings should either be removed or sufficiently small so as to avoid damaging the turf and facilitating mosquito production. Vegetated areas must be inspected at least annually.

Any areas showing erosion, scour, or divots shall be immediately reseeded. In addition, unwanted growth should be removed with minimum disruption to the planting soil bed and remaining vegetation and then reseeded. If ponding longer than 72 hours occurs, action shall be taken to either re-establish the appropriate slope and/or permeability rate of the planting bed.

When establishing or restoring vegetation, biweekly inspections of vegetation health should be performed during the first growing season or until the vegetation is established. Once established, inspections of vegetation health, density, and diversity should be performed at least twice annually during both the growing and non-growing seasons. The vegetative cover on a grass swale must be maintained at 95 percent.

All use of fertilizers, mechanical treatments, pesticides and other means to assure optimum vegetation health should not compromise the intended purpose of the grass swale. All vegetation deficiencies should be addressed without the use of fertilizers and pesticides whenever possible.

Considerations

The planning of a grass swale should consider the topography and geologic and ecological characteristics of both the proposed swale site and contiguous areas. The placement of a grass swale in the vicinity of deciduous trees may require additional inspection or maintenance due to leaves, twigs and branches accumulating in the swale. Consideration for adequate sunlight should be included in the planning for swale placement. Grass swales should not be placed in areas with excessive tree canopy that would inhibit growth.

Installation of grass swales should be carefully considered. The use of turf reinforcements such as pegged sod or erosion mats can protect the swale and help with the stabilization and longevity of the swale.

Locating a grass swale in visible areas will promote maintenance activities. Grass swales should be maintained in a way that prevents the turf from being damaged to avoid unnecessary turf replacement. The maintenance plan should include special equipment that is necessary the maintenance of the swale, such as special mowers to address the side slopes or vacuuming equipment for the swale bottom. The following maintenance methods should be considered: the use of a power core aerator and the bagging of the plugs for removal; and/or the use of a power rake with vacuuming of the swale bottom to remove accumulated sediment and to maintain the design depth.

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